Space Weather Technical Forecast

Issued on Tuesday, 19 July 2022 at 01:24 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/Minor Storms mainly day 1 (19th). Decreasing chance of M-flares (R1/R2 Radio Blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the last 24 hours, with a background of C-class, including a couple of small C1-flares and a C3 just before midnight. There are eight sunspot regions on the visible disc, although AR3055 Eho/Beta is soon expected to rotate off the southwest limb. The main activity is from AR3056 Dri/Beta in the southwest, which was the source of a long-period C1-flare, with the other C1 flare from AR3057 Csi/Beta in the northwest disc. All other regions are smaller and either stable or decaying. The long period C1 flare from AR3056 had an associated CME, however this has yet to be analysed for an Earth-directed component.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1, persisted at around 400 km/s, before a marked enhancement at 18/2035 UTC to 470 km/s. This was accompanied with a density increase from background to around 10 ppcc. The total IMF (interplanetary magnetic field), Bt, had been gradually increasing from weak levels at 5nT, to be Moderate at 8-12nT, before a further step enhancement at 18/2035 UTC to 15nT. The north-south, Bz, direction had been varying between +8 and -8nT, before becoming positive and peaking at 15 nT after 18/2035 UTC. The phi angle, however remained generally positive throughout. This suggests a CME arrival, however the only forecast CME is not expected until later on the 19th or early 20th. It is too early to tell if this is that CME, or another unknown transient. Geomagnetic activity was mainly Quiet, but increased to Unsettled 18/2100-2400 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV), as measured by GOES16, was at Background levels. High energy electron flux was above the high (1000 pfu) threshold at first, peaking 3560 pfu, but then dropped out around 18/0555 UTC, before recovering to mainly moderate levels. The 24-hour integrated electron fluence was above the Active (1e8 integrated pfu) threshold for much of the day, but fell just below at the time of the midnight observation, falling to 8.03e7 at 19/0000 UTC

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low, with a chance of rising to Moderate from any M-flares that occur due to the number of sunspot regions on the visible disc.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on 15 July, has been forecast to arrive at Earth either late on 19 or early on 20 July, with a chance of G1/Minor Storms, although this may be the source of the current enhancement. A small coronal hole fast wind (CH03/-) may also connect with the Earth on day 1 (19th). Further coronal hole fast wind arrivals are then possible either late day 3 or day 4 (21st or 22nd). Geomagnetic activity is forecast to be Quiet to Unsettled at first, but with a chance of rising to Active with G1/Minor Storm intervals with any further CME or coronal hole sourced enhancement. This risk recedes day 2 (20th) with mainly Quiet, with isolated Unsettled intervals returning before a further enhancement later day 3 (21st) or more likely day 4 (22nd) to Unsettled to Active with a chance of G1/Minor Storms.

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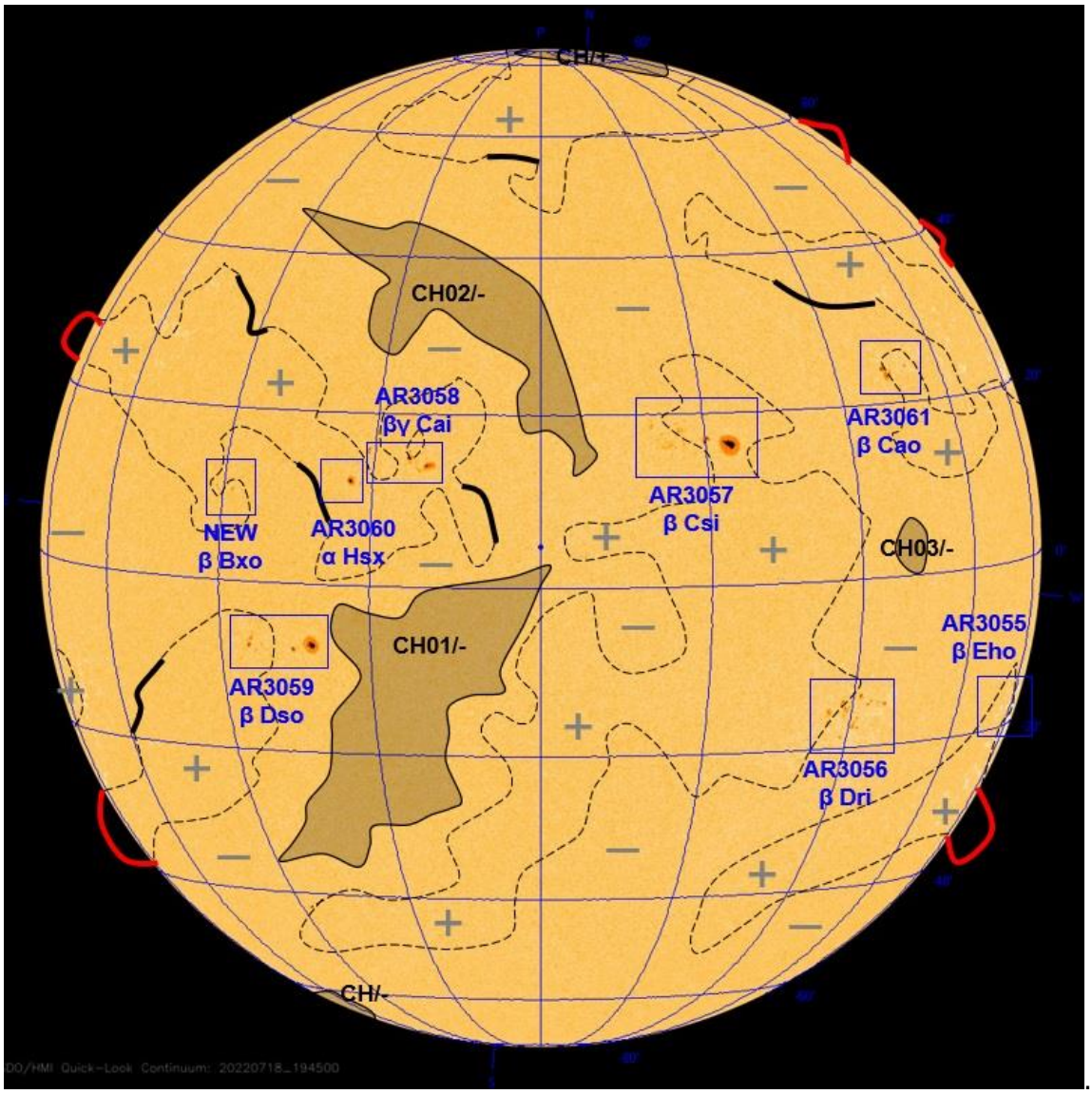
Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is likely to remain at background levels, but with a daily slight chance of S1. The high energy electron flux (greater than 2 MeV) is forecast to be mainly Moderate with a chance of rising to give diurnal peaks at High once current solar wind enhancements recede. This will give a chance of Active (greater than 1e8 integrated pfu) 24-hr fluence returning, mainly day 2 onward, but otherwise fluence is expected to remain below the Active level.

Figure 1. Solar Analysis Valid 18/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one Earth-directed CME, from a filament eruption which let the Sun the 15th. This is forecast to arrive at Earth late on the 19th, with a low probability of an arrival on 20th, however there is the possibility that this is the source of a recent enhancement observed on the 18th.

Another source of potential enhancement is the arrival of the fast wind of negative polarity coronal hole 03. This was likely the source of a small enhancement at STEREO A late on the 16th and early 17th, which observing the solar wind around 2 days before Earth. Whilst the timing would match, the phi angle has yet to switch to negative, and the observed IMF is stronger than that on STEREO A, despite the coronal hole appearing to be closing. Consequently, this is unlikely to be the source with a further small enhancement from this feature still possible on day 1 (19th).

A further possibility is that the expected CME has yet to arrive, and another unexpected transient, ahead of this coronal hole enhancement has arrived. Consequently the CME is still yet to arrive. Regardless of the cause, solar winds are expected to be slightly elevated through day 1 and into day 2 (19th-20th), with the potential for further increases in speed and total IMF, before easing later on day 2 (20th). The pair of large coronal holes CH02 and CH01 are then expected to result in a fast wind arrival at Earth later in the period, potentially day 3 (21st), but more likely day 4 (22nd).

Geomagnetic activity is forecast to be Quiet to Unsettled at first, with moderate IMF, but currently mainly positive Bz. However if this becomes negative, due to any further enhancements from CME or fast wind arrivals on day 1 (19th), then Active to G1/Minor Storm intervals are likely. This risk recedes day 2 (20th) with mainly Quiet, with isolated Unsettled intervals returning before a further enhancement later day 3 (21st) or more likely day 4 (22nd) to Unsettled to Active with a chance of G1/Minor Storms.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	30	10	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/0209 UTC	Partial	Filament Eruption	NW Quadrant	395 km/s	20/2359 UTC +/- 9hrs	Partial halo. Possibly arrived, around 24 hrs early.

Figure 2: Observed Solar winds:

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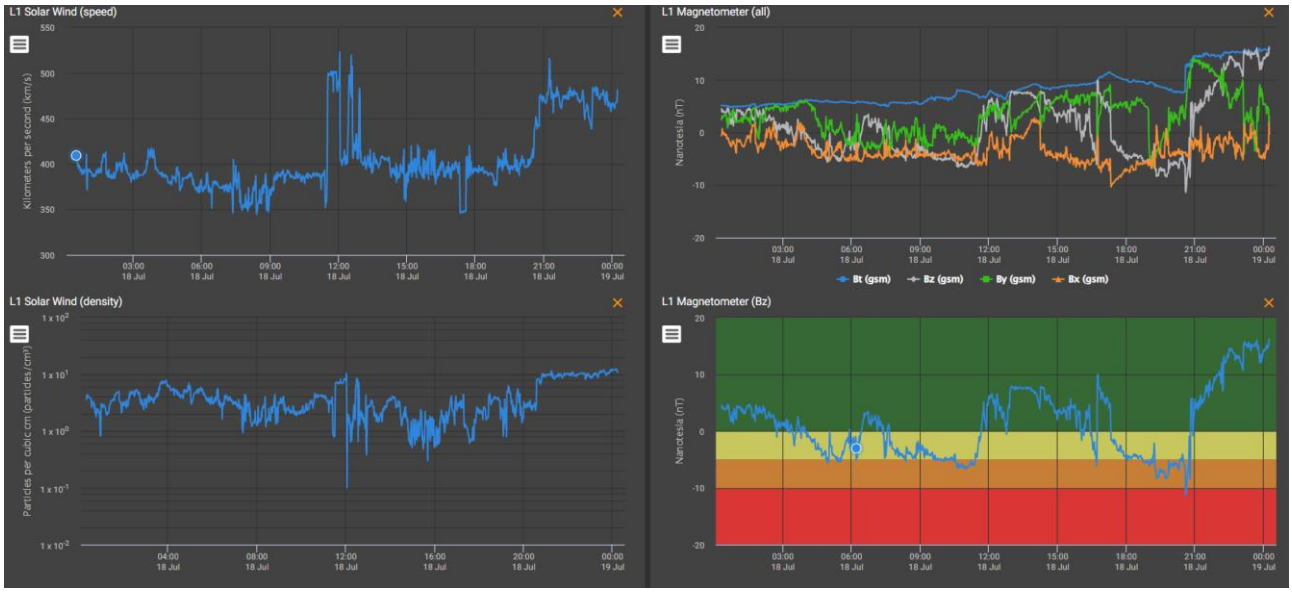
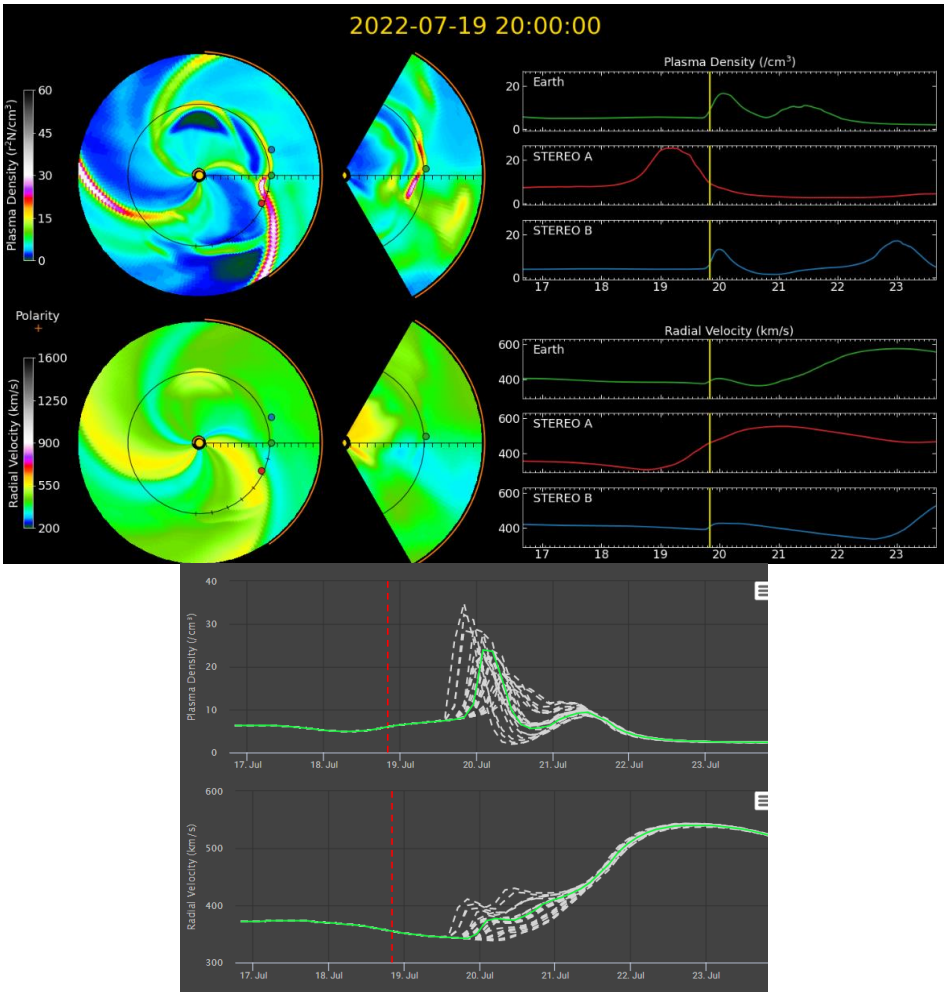


Figure 3: Enlil Forecast including CME arrival and ensemble



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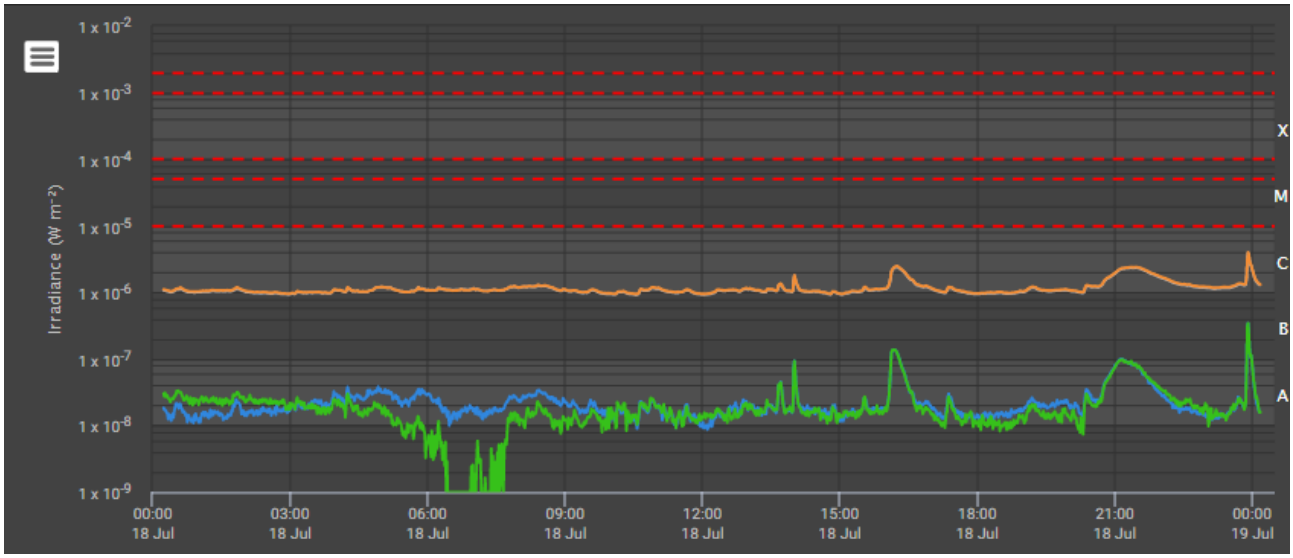
Radio Blackouts - X-Ray Flares:

Solar Activity has been Low with seven numbered sunspots regions on the Earth-facing disc, and a further unnumbered developing region. The largest of these regions AR3055 Eho/Beta will soon rotate off the disc, whilst all other regions remain relatively small and simple. Aside from the new region, these regions have been showing signs of very gradual simplification or have remained largely stable over the last 24 hours. Although a couple of C1 flares have been observed from AR3057 Cai/Beta in the northwest and AR3056 Dri/Beta in the southwest, and a further C3 flare was observed just before midnight.

Activity is expected to remain Low, but with a chance of increasing to Moderate with any isolated M-flares that occur.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	35	30	30
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 4: GOES-16 /17 X-ray flux



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is currently at background levels. There is the potential for proton flux increases due to the complexity of the Earth-facing disc, including regions on or near the west limb. However, these only give a very slight chance of proton flux reaching the S1 level (10 pfu).

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux as measured by GOES-16 has recently dropped out due to recent solar wind enhancement. With further potential enhancements expected day 1 (19th), observed flux levels are likely to remain subdued, before rising again day 2 and into day 3 (20th and 21st) as any solar wind pressure on the Van Allen belts declines. Peak levels are likely to return to moderate with a chance of diurnal peaks at high (greater than 1000 pfu). A further dropout is then possible later day 3 or day 4 (21st or 22nd) due to the fast wind arrivals from the pair of coronal holes CH02 and CH01,

The associated 24 hour fluence has recently fallen below the Active threshold, and with flux levels likely to only gradually return to a diurnal peak of High, there is now only a slight chance of Active fluence returning late day 1 (19th), and a chance of returning through days 2 and day 3 (20th and 21st) as solar winds ease from recent enhancements. REFM is giving a good indication of expected trends, remaining below Active.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	10	30	30	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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Figure 5: GOES-16 >2MeV 24 hr fluence (top) and electron Flux (bottom)

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